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Evolution of diabetes in Brazil: prevalence data from the 2013 and 2019 *Brazilian National Health Survey*

Evolução do diabetes mellitus no Brasil: dados de prevalência da *Pesquisa Nacional de Saúde* de 2013 e 2019

Evolución de la diabetes en Brasil: dados de prevalencia de la E*ncuesta Nacional de Salud brasileña* de 2013 y 2019

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Abstract

The prevalence of diabetes has been growing worldwide. This study aimed to estimate the prevalence of self-reported diabetes in Brazil in 2019, to describe its evolution from 2013, and to evaluate the role of population growth, aging, and other factors in the changes found. The 2019 Brazilian National Health Survey, *a nationally representative cross-sectional survey, queried a physician diagnosis of diabetes in a probabilistic multistage cluster sample. The crude prevalence of known diabetes in 2019 was 7.7% (7.4%-8.0%), a 24% relative increase to the prevalence of 2013. Though this increase was greater in men (30%) than women (20%), 2019 prevalence remained higher in women (8.4%) than in men (6.9%). Age-adjusted prevalence was uniformly lower in the North region, and uniformly higher in the Southeast and Central-West regions. In 2019, 12.3 million cases of diabetes were found, a 36.4% increase from the 9.0 million in 2013. Drivers of this rise include increase in size (9.9%) and aging (1.8%) of the Brazilian population, and to all other factors, including increased case-detection and incidence, as well as decreased diabetes mortality (24.7%). Main correlates of greater prevalence – adjusted by the Poisson regression with robust variance – were older age (PR = 27.2, 95%CI: 1.2-42.9 for ≥ 65 years vs. 18-24 years), hypertension (PR = 2.6, 95%CI: 2.4-2.8 vs. normotension), and obesity (PR = 2.3, 95%CI: 2.1-2.5 vs. BMI < 25kg/m²). Those with a complete higher education had a 40% lower prevalence (PR = 0.6; 95%CI: 0.54-0.70 vs. incomplete elementary education). In conclusion, accompanying a worldwide trend, Brazil presents an increasing prevalence of diabetes throughout its regions, posing a huge burden to its population and health systems.*

Diabetes Mellitus; Cross-Sectional Studies; Prevalence

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Introduction

Noncommunicable diseases are the main causes of disease burden worldwide, challenging health systems, governments, and societies. The United Nations (UN) and the World Health Organization (WHO) have centered preventive focus on five disease groups: cardiovascular diseases, cancer, chronic obstructive lung disease, diabetes, and mental health [1]. Among these, diabetes stands out as the only noncommunicable disease to show a major increase in burden (73%) over the past three decades [2].

The prevalence of diabetes has been growing worldwide, especially in low- and middle-income countries [3]. In Brazil, the most recent national survey reported a prevalence of self-reported, or known, diabetes of 6.2%, indicating that more than 9 million adults had diabetes in 2013 [4]. Since 2006, annual telephone survey in capital cities indicate that age-adjusted prevalence is increasing [5] in both men and women, and recent estimates indicate an overall prevalence of 7.8% in 2019 (vs. 7.2 in 2013) [6].

Population growth and aging, decreased mortality, and increased incidence and diagnosis are factors associated with increasing rates of diabetic individuals. The rising rate of obesity might be related with increasing diabetes incidence [7]. Differences in case detection and underlying risks may result in different values for men and women [8]. The contribution of all these factors to the prevalence of diabetes has been little investigated in the Brazilian population.

This study aimed to estimate the prevalence of self-reported diabetes in Brazil in 2019 and to describe its evolution from 2013, separately for men and women. Additionally, we aimed to evaluate the role of population growth, aging, and other factors in the changes observed.

Methods

The *Brazilian National Health Survey*

The development, sampling frame, field work, questionnaires, and clinical measurements for the *Brazilian National Health Survey* (PNS) in 2013 and 2019 have been previously described in detail [9,10,11]. The Brazilian National Research Ethics Commission approved the PNS 2013 in July 2013 (n. 328,159) and the PNS 2019 in August 2019 (n. 3,529,376). Both surveys comprised a national sample of households and were conducted by the Brazilian Institute of Geography and Statistics (IBGE) in association with the Brazilian Ministry of Health. Each body drew a representative, probabilistic multistage cluster sample with stratification of primary sampling units. The target population of the 2013 survey consisted of individuals aged 18 or over who resided in private households. The 2019 survey was expanded to include individuals aged 15 years or older. Three questionnaires were administered, referring to the household, to all household dwellers, and to a single individual among them. The individual questionnaire – which included a module on the participant's medical history – was answered by a randomly selected dweller. Diabetes was defined by a positive response to the question "Has a physician ever diagnosed you with diabetes?". Women who reported a history of diabetes only during pregnancy were not considered to have diabetes. The remaining information was obtained through the questionnaire. Weight, height, and blood pressure were measured in the 2013 survey. As weight and height were measured only in a subsample in 2019, we used self-reported weight and height to calculate body mass index (BMI) for the 2019 survey.

To allow comparisons between the 2013 and the 2019 editions of the PNS, IBGE performed a new calibration of the PNS 2013 expansion factors considering the revision of the population projection for federative units by sex and age, for the period 2010-2060, released in 2018 [12].

Statistical analyses

Sociodemographic and clinical characteristics were described by frequencies and weighted percentages and the prevalence of diabetes was reported as percentages followed by 95% confidence intervals (95%CI). The prevalence of diabetes in Brazilian states was adjusted using direct standardization to the age distribution estimated by the IBGE for the 2019 Brazilian adult population based on five age groups (18-24 years, 25-39 years, 40-49 years, 50-64 years, and ≥ 65 years) with corresponding

weights (0.14211, 0.30481, 0.18219; 0.22871, and 0.14219). Poisson regression models was fitted using a robust variance estimator to assess factors associated with the prevalence of diabetes in 2019. Prevalence ratios (PR) with 95%CI, both crude and adjusted, were estimated for the sociodemographic variables age, sex, race/skin color, and educational level. The relative change in the prevalence of diabetes was calculated as:

$$\left[\left(p_{\mathrm{DM}_{2019}} - p_{\mathrm{DM}_{2013}}\right)/p_{\mathrm{DM}_{2013}}\right] \times 100\% = \left[\left(p_{\mathrm{DM}_{2019}}/p_{\mathrm{DM}_{2013}}\right) - 1\right] \times 100\% = (PR - 1) \times 100\%$$

ratio, respectively. Das Gupta's [13] decomposition method was used to describe factors associated with the change in the number of cases with known diabetes between 2013 and 2019. Although not replacing the conventional method of age-standardization, this approach allows for a visualization of the forces driving changes in the number of individuals affected over time. To account for the PNS' complex sampling design the R statistical software, version 4.0.4 (http://www.r-project.org), with the survey package was used [14], thus producing results representative of the adult Brazilian population.

Results

In total, 60,202 individuals (aged ≥ 18 years) answered the individual questionnaire in 2013 and 94,114 individuals (aged ≥ 15) in 2019. After excluding individuals < 18 years old, 88,531 remained in 2019.

Table 1 presents sample characteristics for both surveys, overall and by sex. In 2019, 47.7% of the sample were aged 45 years or older, a higher percentage compared to 43.2% in 2013. In both surveys, individuals self-reported as white and mixed-race represented slightly more than 40% of the sample, with blacks representing approximately 10%, and Asians or indigenous the remaining ~1.5%. In 2019, those with incomplete high school comprised 49.3% of the sample a decrease when compared to 54.5% in 2013; and 34.8% did not complete elementary school, down from 39% in 2013. Those overweight or obese comprised 57.9% in 2019, a slightly increase compared to 56.9% in 2013. Hypertension was reported by 23.9% in 2019, increasing 2.5% (21.4%) since 2013. Women were more frequently characterized as obese and presented higher prevalence of hypertension compared to men in both surveys.

As seen in Table 2, the crude prevalence of diagnosed diabetes in 2019 was 7.7% (7.4%-8.0%) in 2019, an increase compared to 6.2% (5.88%-6.56%) in 2013. This overall increase of 24.1% (95% CI: 16.1%-32.7%) reflects an increase that was greater in men (30%, 95%CI: 15.9%-46.0%), than in women (20%, 95%CI: 10.2%-30.6%). Women were more likely to report diabetes than men in both surveys: 8.4% vs. 7.0% in 2019; and 6.9% vs. 5.3% in 2013. Also, diabetes prevalence increases with aging in both surveys, in 2019 0.7% of the individuals aged 18-24 years presented diabetes, and 21.6% of the individuals aged 65 or older presented diabetes. Differences by race/skin color were inconsistent across the two surveys, with point estimates for one group usually falling within the 95%CI of the other groups, except for Asians, in which prevalence in 2019 doubled. Marked differences in prevalence were seen between extremes of educational level in both surveys, with the 2019 prevalence among those with less than complete elementary education being 12.9%, as opposed to 4.7% among those with higher education. Prevalence also increased notably with adiposity and was markedly greater in those reporting hypertension in both surveys. These characteristics were similar for men and women.

Panel A of Figure 1 presents the age-standardized prevalence of diabetes across Brazilian states in 2019. Three Southeast and two Northeast states presented the greatest prevalence, between 8% and 9%. On the other hand, states in the North Region uniformly had a prevalence of less than 7%, and those of the Central-West and South presented a prevalence between 7% and 8%. Panel B of Figure 1 shows the changes in this age-standardized prevalence of diabetes from 2013 to 2019. Decreases were found in 5 states spread across the country; notably, Roraima had more than 10% of prevalence reduction. Many states, especially in the Southeast and Central-West, had slight increases of up to 10%. Six states spread across the South, Northeast and North regions had greater increases, up to 25%, and two (Acre and Espírito Santo) showed increases above 25%. Three Northeast states – Ceará, Rio Grande do Norte, and Paraíba – presented a prevalence increase greater than 30%.

Table 1

Sociodemographic and clinical characteristics of adult participants in the *Brazilian National Health Survey*, 2013 and 2019.

Characteristic	2013				2019			
	n	Total n (%)	Men n (%)	Women n (%)	n	Total n (%)	Men n (%)	Women n (%)
Age (years)	60,202				88,531			
18-24		7,823 (15.9)	3,467 (16.7)	4,356 (15.3)		8,145 (13.9)	3,864 (14.9)	4,281 (13.0)
25-34		13,923 (21.7)	5,877 (22.4)	8,046 (21.0)		15,970 (18.1)	7,606 (18.8)	8,364 (17.5)
35-44		12,817 (19.2)	5,545 (18.9)	7,272 (19.4)		18,033 (20.2)	8,735 (20.2)	9,298 (20.3)
45-54		10,246 (17.5)	4,633 (17.5)	5,613 (17.5)		15,885 (17.8)	7,608 (17.7)	8,277 (18.0)
55-64		7,681 (13.4)	3,276 (13.1)	4,405 (13.7)		14,572 (15.0)	6,857 (14.8)	7,715 (15.3)
≥ 65		7,712 (12.3)	3,122 (11.4)	4,590 (13.0)		15,926 (14.9)	6,992 (13.6)	8,934 (16.0)
Race/Skin color	60,199				88,522			
White		24,106 (47.6)	10,226 (47.0)	13,880 (48.1)		32,409 (43.3)	15,126 (42.5)	17,283 (43.9)
Black		5,631 (9.1)	2,525 (9.1)	3,106 (9.2)		10,132 (11.5)	4,943 (11.6)	5,189 (11.4)
Mixed-race		29,512 (42.0)	12,796 (42.7)	16,716 (41.3)		44,646 (43.8)	20,950 (44.3)	23,696 (43.3)
Asian		533 (0.9)	203 (0.8)	330 (1.0)		665 (0.9)	308 (0.9)	357 (0.9)
Indigenous		417 (0.4)	169 (0.4)	248 (0.5)		670 (0.5)	329 (0.6)	341 (0.5)
Education level	60,202				88,531			
Incomplete elementary		24,083 (39.0)	10,834 (39.9)	13,249 (38.2)		35,572 (34.8)	17,857 (35.5)	17,715 (34.1)
Complete elementary		9,215 (15.5)	4,062 (16.5)	5,153 (14.6)		12,005 (14.5)	5,933 (15.7)	6,072 (13.4)
Complete high shool		19,149 (32.8)	7,916 (32.2)	11,233 (33.3)		27,337 (34.9)	12,342 (34.6)	14,995 (35.2)
Complete higher education		7,755 (12.7)	3,108 (11.4)	4,647 (13.9)		13,617 (15.8)	5,530 (14.2)	8,087 (17.3)
Body mass index (kg/m^2)	59,402				87,678			
Low/Normal (< 25)		25,446 (43.1)	11,455 (44.5)	13,991 (41.8)		36,908 (42.0)	17,271 (40.8)	19,637 (43.2)
Overweight (25-29.9)		21,598 (36.1)	10,095 (38.7)	11,503 (33.8)		32,744 (36.7)	16,739 (40.0)	16,005 (33.8)
Obesity (≥ 30)		12,358 (20.8)	4,370 (16.8)	7,988 (24.4)		18,026 (21.2)	7,652 (19.2)	10,374 (23.1)
Hypertension	60,202				88,531			
Yes		12,500 (21.4)	4,517 (18.1)	7,983 (24.3)		22,550 (23.9)	9,378 (21.1)	13,172 (26.4)
No		47,702 (78.6)	21,403 (81.9)	26,299 (75.7)		65,981 (76.1)	32,284 (78.9)	33,697 (73.6)

Note: due to rounding, the sum of the relative frequencies may differ from 100%.

Extrapolating the data from these surveys regarding the Brazilian population allows for the estimation that in 2013, 9 million Brazilians had a diagnose of diabetes, and in 2019, 12.3 million Brazilians, an overall increase of 36.4% in six years. As seen in Panel C of Figure 1, decomposition of this increase shows that 9.9% can be attributed to the population growth and 1.8% to the aging of the population. The remaining 24.7% was due to the multiple additional factors. The roles of population growth and aging were larger among women; for men, the other factors were larger.

Figure 2 depicts the resulting ranking of Brazilian states by their age-standardized prevalence of self-reported diabetes and indicates the changes from 2013 to 2019. Major changes occurred in individual state rankings between 2013 (left) and 2019 (right), the two Northeast (green) states of Ceará – moving up from 25th to 2nd in rank – and Rio Grande do Norte – rising from the 16th to the 1st rank – are the most noteworthy changes. Many other Northeastern states also presented increases. States in the North (blue) and Central-West (red) regions generally declined in rank. In the Southeast (orange), São Paulo and Minas Gerais kept their rank, while Rio de Janeiro rose from 18th to 4th place. South (purple) region presented inconsistent change among states.

Table 3 presents 2019 diabetes prevalence ratios across socioeconomic and clinical categories, both for crude and when adjusted for age, sex, race/skin color, and education level. The adjusted prevalence in those individuals aged 65 years or older was 27.2 (17.3-42.9) times the prevalence of 18-24 age group. The difference by age was even greater among women PR = 47.3 (28.8-78.0). Preva-

Table 2

Prevalence of diabetes mellitus in adults overall and by sex according to sociodemographic and clinical characteristics. *Brazilian National Health Survey*, 2013 and 2019.

Characteristic	2013						2019					
	Total		Men		Women		Total		Men		Women	
	%	95%CI	%	95%CI	%	95%CI	%	95%CI	%	95%CI	%	95%CI
Total	6.2	5.9-6.6	5.3	4.8-5.8	7.0	6.5-7.5	7.7	7.4-8.0	6.9	6.5-7.4	8.4	8.0-8.8
Age (years)												
18-24	0.5	0.3-0.8	0.4	0.1-0.7	0.6	0.2-1.1	0.7	0.4-1.1	1.0	0.4-1.7	0.4	0.2-0.6
25-34	0.8	0.6-1.0	0.7	0.4-1.1	0.9	0.6-1.2	0.9	0.7-1.2	0.7	0.3-1.0	1.1	0.8-1.5
35-44	2.9	2.4-3.4	2.4	1.7-3.2	3.4	2.6-4.1	3.1	2.7-3.6	3.1	2.5-3.8	3.2	2.5-3.8
45-54	6.6	5.8-7.4	5.8	4.6-6.9	7.3	6.2-8.4	7.7	6.9-8.5	6.9	5.8-8.0	8.4	7.2-9.6
55-64	13.5	12.1-14.9	12.1	9.8-14.3	14.7	12.8-16.6	14.8	13.8-15.7	13.6	12.2-15.0	15.8	14.5-17.1
≥ 65	19.8	18.2-21.3	17.7	15.1-20.3	21.4	19.3-23.5	21.6	20.5-22.7	20.2	18.6-21.9	22.7	21.2-24.1
Race/Skin color												
White	6.7	6.1-7.2	6.0	5.2-6.8	7.3	6.5-8.0	8.0	7.6-8.5	7.9	7.1-8.6	8.2	7.5-8.9
Black	7.3	6.0-8.6	5.5	3.4-7.5	8.9	7.2-10.5	7.8	7.0-8.7	6.9	5.7-8.0	8.7	7.5-9.9
Mixed-race	5.5	5.0-5.9	4.5	3.8-5.1	6.4	5.7-7.0	7.3	6.9-7.7	5.9	5.3-6.4	8.5	7.9-9.1
Asian	6.3	3.0-9.6	7.3	0.9-13.7	5.6	2.2-9.0	12.8	7.9-17.7	13.6	6.3-21.0	12.0	5.5-18.5
Indigenous	6.9	2.7-11.1	5.4	1.8-18.7 *	8.0	2.8-13.2	7.5	4.4-10.6	5.2	1.4-8.9	10.2	5.3-15.1
Education level												
Incomplete elementary	9.6	9.0-10.3	6.7	5.8-7.5	12.4	11.3-13.4	12.9	12.3-13.5	10.2	9.4-11.0	15.4	14.4-16.3
Complete elementary	5.4	4.5-6.3	5.4	4.0-6.9	5.4	4.3-6.5	6.3	5.5-7.0	5.4	4.4-6.4	7.1	6.1-8.2
Complete high school	3.4	2.9-3.8	3.5	2.8-4.2	3.3	2.7-3.8	4.6	4.2-5.0	4.6	4.0-5.2	4.6	4.1-5.1
Complete higher education	4.1	3.3-5.0	5.5	3.9-7.2	3.1	2.3-4.0	4.7	4.1-5.2	6.0	5.0-7.1	3.6	3.1-4.2
Body mass index (kg/m^2)												
Low/Normal (< 25)	3.6	3.2-4.0	3.4	2.9-4.0	3.8	3.3-4.3	4.9	4.6-5.3	4.5	4.0-5.1	5.2	4.8-5.7
Overweight (25-29.9)	6.6	6.0-7.2	5.3	4.4-6.1	7.9	7.1-8.8	8.3	7.8-8.8	7.6	7.0-8.3	9.0	8.3-9.7
Obesity (≥ 30)	11.3	10.3-12.3	10.4	8.6-12.1	11.9	10.7-13.1	12.6	11.7-13.4	10.4	9.1-11.7	14.2	13.0-15.4
Hypertension												
Yes	18.2	17.0-19.5	17.0	14.8-19.1	19.1	17.5-20.6	20.6	19.7-21.5	18.7	17.3-20.1	21.9	20.8-23.1
No	3.0	2.7-3.2	2.7	2.3-3.1	3.2	2.8-3.5	3.7	3.4-3.9	3.8	3.4-4.2	3.6	3.3-3.9

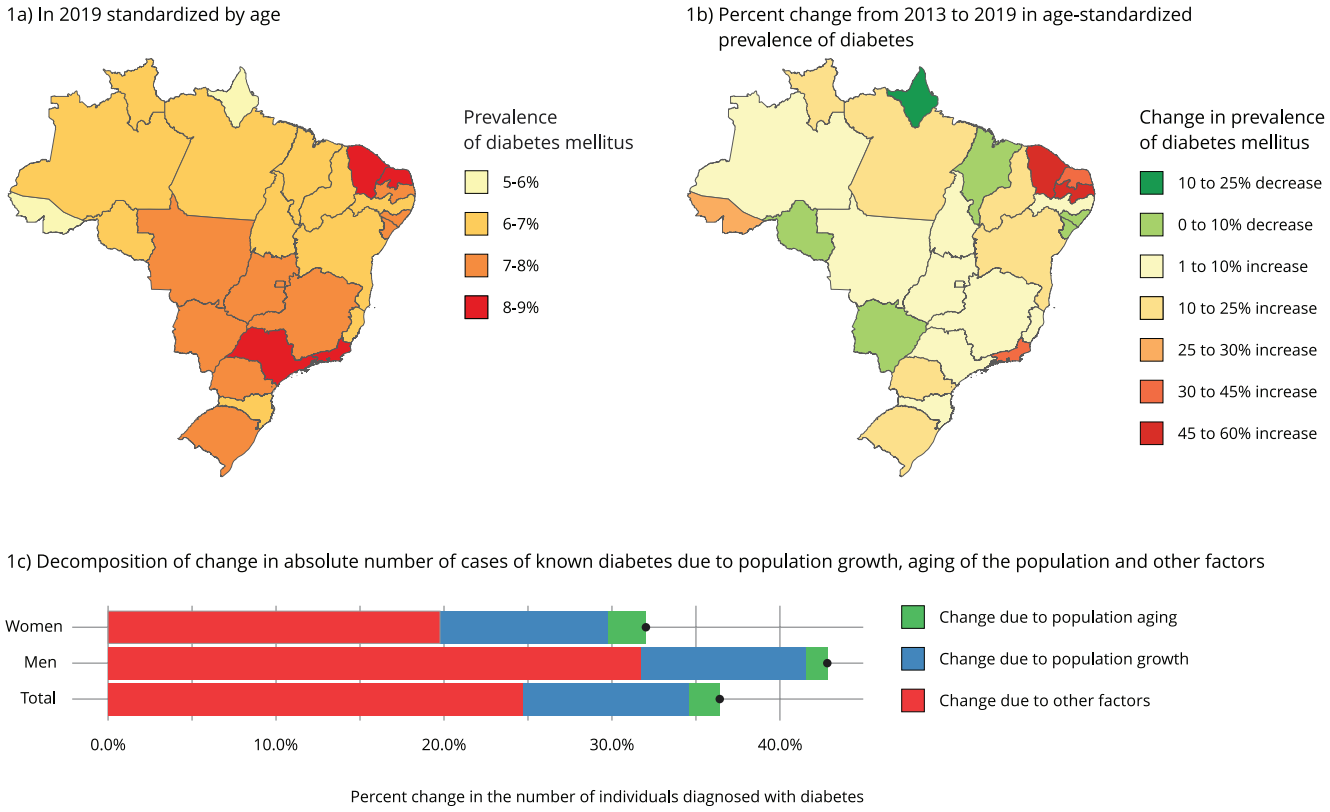
95%CI: 95% confidence interval.

* Logit transformation confidence interval for this group due to its small number.

lence was similar among those self-declared as white, mixed-race, black, and indigenous, but was 59% (8%-133%) greater among those self-declared as Asian, when compared to whites. Overweight individuals had a 52% (39%-67%) greater prevalence and obese individuals a 128% (108%-150%) greater prevalence than those with BMI under 25kg/m^2. Those who reported having hypertension had a 162% (140%-185%) greater prevalence than those with normotension. These differences were generally consistent across sex categories, though women had a much greater gradient across age and a somewhat lesser gradient across educational level than men.

Figure 1

Prevalence of diabetes in adults ages 18 and over. *Brazilian National Health Survey*, 2013 and 2019.



Discussion

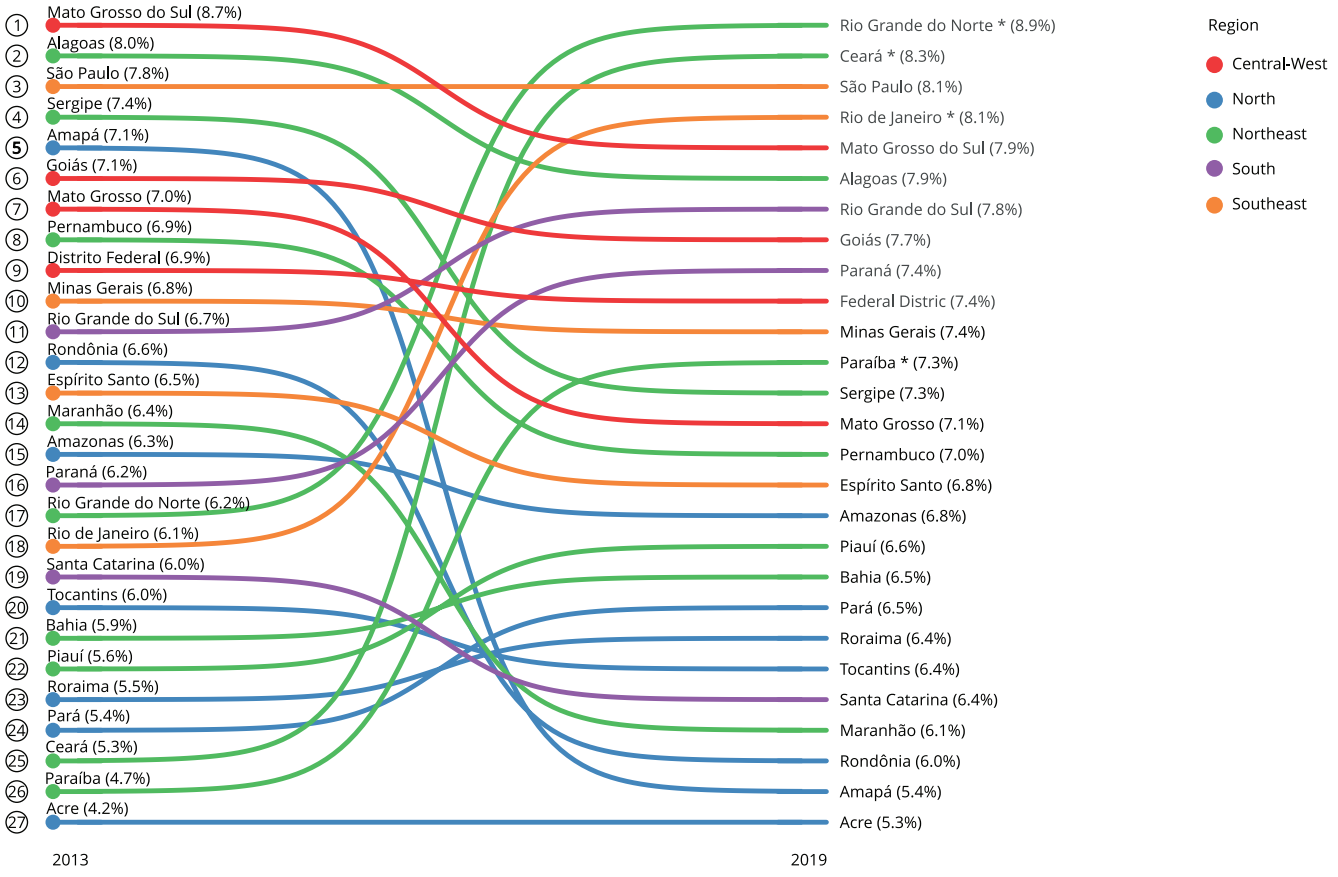
In the 2019 PNS, 7.7% (7.4%-8.0%) of adults aged 18 years or older reported having diabetes, slightly more women than men. The crude prevalence of self-reported diabetes increased 24% between 2013 and 2019, this increase was greater in men than in women. Based on these estimates, 12.3 million Brazilian adults were diagnosed with diabetes in 2019, a 35% increase from the 9.0 million estimated in 2013. In 2019, older age, hypertension, and obesity were associated with a greater prevalence; higher education (complete university) with a lower one. Prevalence was lowest, in general, in states in the North and parts of the Northeast regions.

An ongoing increase in the prevalence of self-reported diabetes in Brazil has been previously documented. Annual Vigitel (*Risk and Protective Factors Surveillance System for Chronic Non-Comunicable Diseases Through Telephone Interview*) surveys in capital cities indicated an increase in age-adjusted prevalence between 2006 and 2014, even after considering the sociodemographic and nutritional changes during the period [5]. Recent Vigitel estimates confirm this increasing trend, with a 7.8% prevalence of self-reported diabetes in 2019 [6].

Our findings show that population growth and aging contributed to less than one-third (10.7% out of the 36.4%) of the rise in the absolute number of Brazilian adults diagnosed with diabetes, that is, 24.7% of the increase is related to additional factors. A greater role of population aging was observed among women, probably related to their greater longevity.

Figure 2

Ranking of Brazilian states by age-standardized self-reported prevalence of diabetes. *Brazilian National Health Survey*, 2013 and 2019.



* States presented a statistically significant change from 2013 to 2019 in age-standardized prevalence of diabetes (p-value < 0.05).

Additional factors contributed to a much larger fraction, particularly among men, requiring further investigation. One of these factors may be the increase in case-detection, which may vary by sex and could raise prevalence of self-reported diabetes even without changing its total prevalence. Mortality among individuals with diabetes may be another decreasing factor, a trend observed during the period of 1996 to 2011 [15] and could have been present during 2013-2019. Furthermore, with major public health importance, the increase in prevalence here described is probably, caused by an increase in the incidence of diabetes [16]. Multiple factors could increase the incidence of diabetes, but the increase in unhealthy eating habits and obesity are likely key aspects [2]. This is consistent with the large diabetes associations we observed in 2019 for BMI categories. Moreover, the greater increase in the prevalence of overweight and obesity in men than in women from 2013 to 2019 may partially explain the greater increase in the prevalence of diabetes in men. The large increases observed for some states, Ceará, Rio Grande do Norte, Paraíba, and Rio de Janeiro – although likely to result from increased incidence – could result from increased case-detection or decreased mortality, as a consequence of increased access to primary health care services. These issues are greatly significant to the public health and deserve further investigation.

Table 3

Crude and adjusted * prevalence ratio (PR) for diabetes in adults, overall and stratified by sex, in accordance with sociodemographic and clinical characteristics. *Brazilian National Health Survey*, 2019.

Characteristic	Total				Men				Women			
	Crude		Adjusted		Crude		Adjusted		Crude		Adjusted	
	PR	95%CI	PR	95%CI	PR	95%CI	PR	95%CI	PR	95%CI	PR	95%CI
Age (years)												
18-24	1.00		1.00		1.00		1.00		1.00		1.00	
25-34	1.25	0.74-2.13	1.30	0.77-2.22	0.64	0.29-1.44	0.65	0.29-1.44	2.77	1.54-4.98	2.95	1.64-5.31
35-44	4.34	2.69-7.00	4.41	2.74-7.10	3.01	1.59-5.68	3.03	1.61-5.70	7.74	4.56-13.16	7.92	4.66-13.49
45-54	10.64	6.73-16.84	10.41	6.58-16.46	6.69	3.69-12.12	6.68	3.68-12.13	20.51	12.30-34.22	19.66	11.08-32.75
55-64	20.36	12.84-32.27	19.45	12.26-30.88	13.07	7.08-24.12	12.90	6.96-23.88	38.56	23.50-63.25	35.65	21.67-58.66
≥ 65	29.82	18.95-46.92	27.20	17.25-42.90	19.47	10.65-35.59	19.09	10.37-35.12	55.44	33.82-90.87	47.35	28.75-77.98
Race/Skin color												
White	1.00		1.00		1.00		1.00		1.00		1.00	
Black	0.97	0.86-1.10	1.07	0.96-1.21	0.87	0.72-1.06	1.02	0.85-1.23	1.06	0.90-1.25	1.11	0.96-1.30
Mixed-race	0.90	0.83-0.98	1.03	0.95-1.11	0.75	0.66-0.85	0.88	0.78-1.00	1.04	0.93-1.16	1.14	1.03-1.27
Asian	1.59	1.08-2.33	1.53	1.07-2.18	1.75	1.00-3.00	1.60	0.92-1.77	1.46	0.85-2.53	1.42	0.89-2.27
Indigenous	0.93	0.61-1.41	1.03	0.69-1.59	0.66	0.32-1.36	0.83	0.42-1.61	1.24	0.77-2.02	1.20	0.72-2.00
Education level												
Incomplete elementary	1.00		1.00		1.00		1.00		1.00		1.00	
Complete elementary	0.48	0.43-0.55	0.93	0.82-1.06	0.53	0.44-0.64	1.04	0.86-1.25	0.47	0.40-0.55	0.86	0.73-1.01
Complete high school	0.36	0.32-0.39	0.82	0.74-0.91	0.45	0.39-0.52	1.96	0.82-1.12	0.30	0.26-0.34	0.73	0.63-0.83
Complete higher education	0.36	0.32-0.41	0.61	0.54-0.70	0.59	0.49-0.72	0.89	0.73-1.07	0.24	0.20-0.28	0.44	0.37-0.52
Body mass index (kg/m^2)												
Low/Normal (< 25)	1.00		1.00		1.00		1.00		1.00		1.00	
Overweight (25-29.9)	1.69	1.54-1.85	1.52	1.39-1.67	1.68	1.46-1.93	1.57	1.37-1.80	1.72	1.52-1.94	1.46	1.30-1.64
Obesity (≥ 30)	2.55	2.31-2.81	2.28	2.08-2.50	2.29	1.94-2.69	2.20	1.89-2.57	2.70	2.39-3.06	2.27	2.02-2.55
Hypertension												
Yes	1.00		1.00		1.00		1.00		1.00		1.00	
No	5.59	5.18-6.04	2.62	2.40-2.85	4.94	4.37-5.59	2.41	2.12-2.74	6.11	5.52-6.76	2.74	2.44-3.08

95%CI: 95% confidence interval.

* Adjustment for total sample: age, sex, race/skin color, educational attainment; for men and women: age, race/skin color, educational attainment.

The upward trend in the prevalence of individuals diagnosed with diabetes results in a major and increasing burden to the population. For example, a current estimate suggests that 20 to 30% of young Brazilians will develop diabetes over their lifetimes. Men diagnosed with diabetes at age 50 are expected to live 19 years with the disease and lose 5.2 years of life expectancy; women diagnosed at the same age are expected to live 24 years with diabetes and lose 2.1 years of life expectancy [17]. The health care expenditure with diabetes has increasingly become significant; estimates indicate it costs 0.5% of the Brazilian gross domestic product [18].

When considering the international context, the increase observed in Brazil is followed by a general increase in prevalence of diabetes worldwide [3], most notably in low- and middle-income countries. Other South American countries have also suffered notable increases in prevalence of diabetes over the last decade [2].

Potential limitations of our study should be mentioned. Firstly, diabetes was defined by self-report, leading to underestimation of total prevalence. In the laboratory extension of the 2013 PNS, prevalence of diabetes defined by a glycated hemoglobin ≥ 6.5% or use of medication was 12% higher than the value achieved through self-report in the same subjects [19]. Secondly, only residents of pri-

vate households were interviewed, thus excluding residents of assisted living residences/facilities for whom diabetes is likely to be more frequent, which might lead to underestimation. Thirdly, though the 2013 and 2019 surveys were quite large, the overlapping 95%CI suggest that many of the differences found across categories within variables may have resulted from sampling error. Also, BMI was assessed by self-reported weight and height in the 2019 survey, with misclassification possibly affecting the associations between obesity and diabetes. However, high agreement between self-reported and measured weight, height, and body mass index was observed in the PNS 2013 for Brazilian adults [20]. Finally, the cross-sectional design of the PNS survey includes different participants in each sample, thus limiting the associations between individuals.

One of the main strengths of our analysis is the representative nature of our data, enabling generalization of our results to the Brazilian adult population. The large sample size of the 2019 survey allows for precise estimates at the national level as well as estimates – although less accurate – for individual Brazilian states and other subgroups of the population. The fact that two national health surveys have now been conducted enabled us demonstrate the large upward trend in the prevalence of diabetes, and our decomposition analysis allows a understanding of the major importance of causes other than population growth and aging in the increase in the prevalence of diabetes between 2013 and 2019.

In conclusion, the prevalence of diabetes, when confirmed by self-report, is increasing in Brazil mainly due to factors other than the growth and aging of the population. Greater prevalence is associated with obesity, hypertension, and lesser educational level. These findings have significant implications for Brazil's policy.

Contributors

R. C. P. Reis contributed to the study design, data analysis, interpretation of results, writing the manuscript. B. B. Duncan and M. I. Schmidt contributed to the study design, interpretation of results and writing the manuscript. D. C. Malta and B. P. M. Iser contributed to the data interpretation, and reviewing the manuscript for intellectual content. All authors approved the final version of the manuscript for publication.

Additional informations

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Resumo

A prevalência do diabetes mellitus tem crescido em nível global. O estudo buscou estimar a prevalência de autorrelato de diabetes no Brasil em 2019, descrever a evolução a partir de 2013 e avaliar o papel do crescimento demográfico, envelhecimento e outros fatores observados. A Pesquisa Nacional de Saúde *de 2019, um inquérito transversal com representatividade nacional, perguntou sobre diagnóstico médico de diabetes em uma amostra probabilística por conglomerados com múltiplos estágios. A prevalência bruta de diabetes conhecido em 2019 foi de 7,7% (7,4%-8,0%), um aumento de 24% em relação à prevalência em 2013. Embora o aumento relativo tenha sido maior em homens (30%) que em mulheres (20%), a prevalência em 2019 permaneceu mais elevada em mulheres (8,4%) que em homens (6,9%). A prevalência ajustada por idade foi consistentemente mais baixa na Região Norte, e consistentemente mais alta nas regiões Sudeste e Centro-oeste. Em 2019, foram diagnosticados 12,3 milhões de casos de diabetes, um aumento de 36,4% em relação aos 9,0 milhões de casos em 2013. Fatores que explicam esse crescimento incluem aumento do tamanho (9,9%) e do envelhecimento (1,8%) da população brasileira, e outros fatores como o aumento na detecção de casos e na incidência, além de uma queda na mortalidade por diabetes (24,7%). As principais associações para uma maior prevalência – ajustada por regressão de Poisson com variância robusta – foram idade mais velha (RP = 27,2; IC95%: 1,2-42,9 para ≥ 65 anos* vs. *18-24 anos), hipertensão (RP = 2,6; IC95%: 2,4-2,8* vs. *normotensão) e obesidade (RP = 2,3; IC95%: 2,1-2,5* vs. *IMC < 25kg/m²). Indivíduos com Nível Universitário completo tiveram uma prevalência 40% mais baixa (RP = 0,6; IC95%: 0,54-0,70* vs. *Fundamental incompleto). Como conclusão, refletindo uma tendência mundial, o Brasil apresenta prevalência crescente de diabetes em todas as macrorregiões, o que cria uma enorme carga para a população e os sistemas de saúde.*

Diabetes Mellitus; Estudos Transversais; Prevalência

Resumen

La prevalencia de la diabetes ha estado creciendo alrededor de todo el mundo. El objetivo de este estudio fue estimar la prevalencia de la diabetes autoinformada en Brasil en 2019, para describir su evolución desde 2013, así como para evaluar el papel del crecimiento de la población, envejecimiento, y otros factores en los cambios encontrados. Se utilizó la Encuesta Nacional de Salud *brasileña de 2019, una encuesta transversal representativa nacionalmente, donde se consultó el diagnóstico médico de diabetes en una muestra probabilística por conglomerados multietapa. La prevalencia cruda de la diabetes conocida en 2019 fue 7,7% (7,4%-8,0%), con un 24% de incremento relativo respecto a la prevalencia de 2013. Sin embargo, este aumento fue mayor en hombres (30%) que en mujeres (20%). La prevalencia de 2019 permaneció más alta en mujeres (8,4%) que en hombres (6,9%). La prevalencia ajustada a la edad fue uniformemente más baja en la Región Norte, y uniformemente más alta en las regiones del Sudeste y Centro-oeste. En 2019, hubo 12,3 millones de casos de diabetes, lo que supuso un incremento de 36.4% desde los 9,0 millones en 2013. Las causas incluyen el aumento de peso (9,9%) y el envejecimiento (1,8%) de la población brasileña, así como para el resto de todos los factores, incluyendo el incremento de la detección de casos e incidencia, al igual que el decremento en la mortalidad por diabetes (24,7%). Los principales factores de correlación para una mayor prevalencia -ajustados por regresión de Poisson con variancia robusta- fueron una edad más avanzada (PR = 27,2; IC95%: 1,2-42,9 para ≥ 65 años vs. 18-24 años), hipertensión (PR = 2,6; IC95%: 2,4-2,8 vs. normotensión), y obesidad (PR = 2,3; IC95%: 2,1-2,5 vs. BMI < 25kg/m²). Quienes contaban con una educación superior completa tenían una prevalencia un 40% más baja (PR = 0,6; IC95%: 0,54-0,70 vs. quienes tenían la educación básica incompleta). En conclusión, acompañando una tendencia global, Brasil presenta un incremento de prevalencia de la diabetes a través de sus regiones, planteando una carga inmensa para su población y sistemas de salud.*

Diabetes Mellitus; Estudios Transversales; Prevalencia

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